

**SMART TWEEZERS**  
**R-C-L METER**

User's Manual  
Version 1.1  
April 2006

## TABLE OF CONTENTS

NOTICE .....	3
WARRANTY.....	3
SAFETY PRECAUTIONS.....	4
GETTING STARTED .....	5
Overview .....	5
General Summary .....	6
Power On.....	7
Display .....	8
Menu Structures And Functions .....	9
MEASUREMENT FEATURES .....	13
Measuring Resistance .....	13
Measuring Capacitance .....	13
Measuring Inductance .....	14
Testing Continuity .....	14
Measuring Voltage .....	14
MAINTENANCE .....	16
LABELLING & VERIFICATION REQUIREMENTS .....	17
APPENDIX A. SPECIFICATIONS .....	18
APPENDIX B. DEFAULT SETTINGS .....	19
APPENDIX C. SERVICE REQUEST FORM .....	20

## NOTICE

Tot the best of our knowledge this document is believed to be accurate. The manufacturer reserves the right to change the information and does not assume any responsibility for omissions and / or errors found in this document.

## WARRANTY

Analog Equipment Corporation (AEC) warrants this product to be free from defects in materials and workmanship for a period of one (1) year from the shipment date. AEC warrants the following items for ninety (90) days from the date of shipment: rechargeable batteries, disks and documentation. During the warranty period, the manufacturer will, at its discretion, either repair or replace any product that proves to be defective. To exercise this warranty, write or call your local AEC representative, or contact AEC headquarters in Waterloo, ON. You will be given prompt assistance and return instructions. Please send the product with shipping prepaid to the indicated service facility. Repairs will be made and the product will be returned to you. Repaired or replaced products are warranted for the balance of the original warranty period, or ninety (90) days from the date of the repair.

This warranty does not cover the repair of any product whose serial number has been altered, defaced or removed. This warranty does not cover finishes (scratches on surface or screen), normal wear and tear, nor does it cover damage resulting from misuse, dirt, liquids, proximity or exposure of heat, accident, abuse, neglect, misapplication, operation outside of the environmental specifications, tampering, unreasonable use, service performed or attempted by unauthorized service centers, failure to provide reasonable and necessary maintenance.

This warranty does not apply to defects resulting from product modification without AEC express written consent, or misuse of any product or part. This warranty also does not apply to software, non-rechargeable batteries, damage from battery leakage, and improper polarity of the batteries or problems arising from normal wear or failure to follow instructions. This warranty does not cover LCD damage, physical damage to the Jog Dial button, slide switch and reset switch; electrical damage of the product due to high voltage or improper battery type.

The design and implementation of any circuit based on this product is the sole responsibility of the customer. Analog Equipment Corporation does not warrant any damage that occurs as a result of the user's circuit or any defects that result from user-supplied products. This warranty does not apply to repairs or replacements necessitated by any cause beyond the control of factory including, but not limited to, operation contrary to furnished instructions, shipping accidents, modification or repair by the user, neglect, accidents or other Acts of God.

The foregoing is in lieu of all other expressed warranties and AEC does not assume or authorize any party to assume for it any obligation or liability. The duration of any warranties that may be implied by law (including the warranties of merchantability and fitness) is limited to the term of this warranty. In no event shall AEC be liable for special, incidental or consequential damages arising from ownership or use of this product, or for any delay in the performance of its obligations under this Warranty due to causes beyond its control. This Warranty is limited in duration to one (1) year from the date of original purchase.

**THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE. THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. NEITHER AEC, NOR ANY OF ITS EMPLOYEES SHALL BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OF ITS DEVICES AND SOFTWARE EVEN IF ANALOG EQUIPMNENT CORPORATION, HAS BEEN ADVISED IN ADVANCE OF THE POSSIBILITY OF SUCH DAMAGES. SUCH EXCLUDED DAMAGES SHALL INCLUDE, BUT ARE NOT LIMITED TO: COSTS OF REMOVAL AND INSTALLATION, LOSSES SUSTAINED AS THE RESULT OF INJURY TO ANY PERSON, OR DAMAGE TO PROPERTY.**

## **SAFETY PRECAUTIONS**

The following safety precautions should be observed prior to using this product and any associated accessories. Although devices and accessories would normally be used with non-hazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read and follow all installation, operation, and maintenance instructions carefully before using the product. Refer to the manual for complete product specifications.

If the product is used in a manner not specified, the protection provided by the product may be impaired.

- Inspect the Smart Tweezers case before using. Do not use the device if it appears to be damaged.
- Do not use the device if it operates abnormally.
- Do not attempt to measure any components in-circuit when your circuit is alive or active.

To avoid possible damage to Smart Tweezers or to the equipment under test, follow these guidelines:

- Disconnect circuit power supply and discharge all high-voltage capacitors before testing resistance, inductance, or capacitance.
- Do not apply external voltages more than 800 mV when ST in automatic mode.
- Do not apply more than 8V in voltage measurement mode.
- Use proper terminals and functions for your measurements.
- Use the proper batteries to power Smart Tweezers.

### Safety symbols and terms

The **WARNING** heading in this manual indicates dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading in the manual indicates hazards that could damage the device. Such damage may invalidate the warranty.

## GETTING STARTED

This section summarizes basic operation of the Smart Tweezers. It is organized as follows:

- Overview – Overview of the device
- General summary – Summarizes basic device features.
- Power-on – Describes the power-on and power-off sequence, the warm-up time, and default conditions.
- Display – Discusses the display format and messages that may appear while using the device.
- Menu structure – Covers menu structure, system settings and features

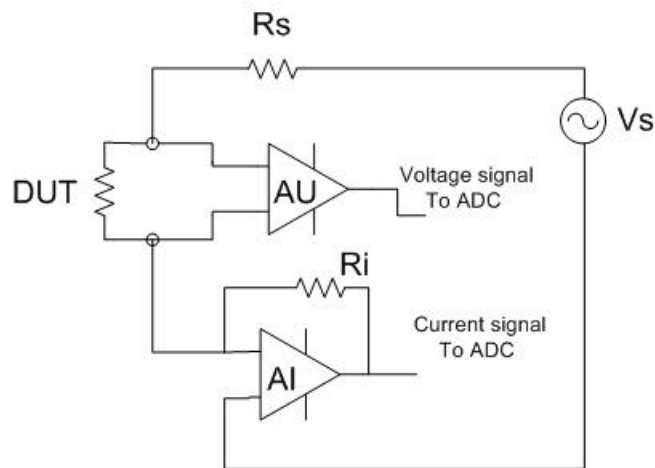
### Overview

The Smart Tweezers R-C-L meter (ST) is a portable impedance measuring device, capable of measuring resistance, capacitance or inductance over a range of more than eight (8) orders of magnitude. The Smart Tweezers has a basic accuracy of 1% (resistance) and has three (3) test frequencies.

ST is controlled by a microcontroller that operates the display and user interface, sets measurement conditions and processes data. The device has a unique mechanical design that allows measuring small SMT components with size down to 0201.

### How ST Works

ST measures impedance of a component by measuring the voltage across the component and current through it. The complex ratio of voltage to current is equal to the complex impedance. The processor calculates the various parameters that are displayed i.e. R, C or L.

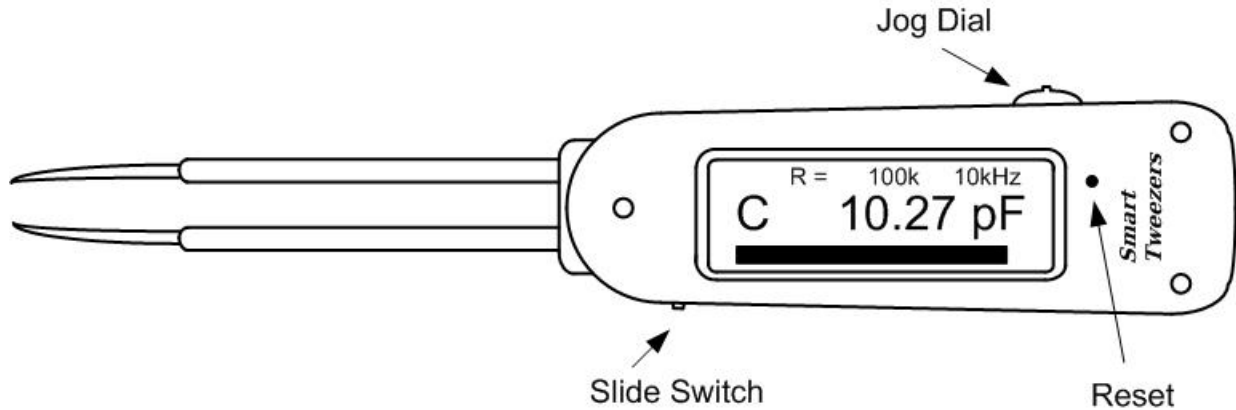


The voltage across the component is generated by test signal source  $V_s$ . Both the amplitude and frequency of  $V_s$  can be set. This voltage is applied to the device under test (DUT) through source resistance  $R_s$ . The current flows to the virtual ground of current amplifier AI, and through  $R_i$ , the current conversion resistor. The output of AI provides a signal proportional to the current,  $I \cdot R_i$ .

The voltage across the DUT is measured by voltage amplifier AU with a separate signal path, thus providing a pseudo 4-wire Kelvin connection.

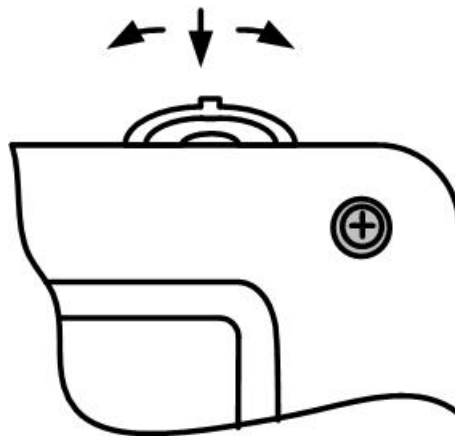
Voltage and current signals are transmitted via an A/D converter to the microprocessor. These values are thereby corrected by using calibration factors, converted to impedance, and the appropriate parameters are displayed.

### General Summary



#### The Jog Dial Button

The Jog Dial button is used to select a function or to change a setting.



#### Reset Button

The reset button resets the unit.

#### Virtual Ground (Optional)

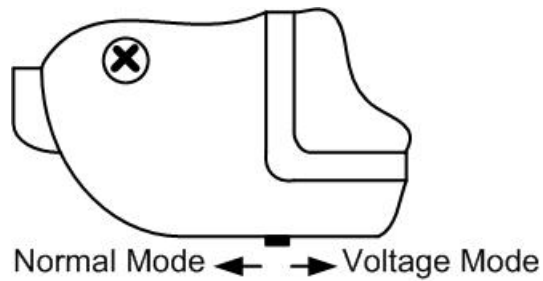
Use the Virtual Ground connector when performing in-circuit measurements to eliminate the influence of grounded components. Connect this point to the circuit Ground.

**CAUTION:** Do NOT use the virtual ground when the tested circuit is alive.

#### Slide Switch

The slide switch enables AC/DC voltage measurements

**CAUTION:** Do not apply more than 1.6 V to the device if slide switch is in Normal Mode position



## Power On

### Power-on

To turn the Smart Tweezers ON, press the Jog Dial button. The symbol in the bottom left corner of the display indicates that the device is ON and ready to perform measurements.

**Note:** Once powered on, the device will perform the last selected function.

### Power-off

The unit powers off automatically, the display goes blank and the device goes into a "sleep" mode if no component has been measured or Jog Dial pressed for approximately 30 seconds. You can set power off timeout by changing TIMEOUT setting in DISPLAY menu.

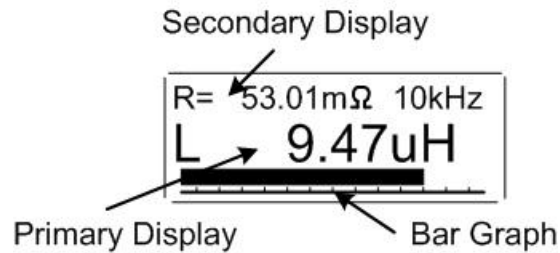
**NOTE:** Automatic power off does not occur when the device is in VOLTAGE or TRACE mode.

### Default power-off settings

By default power-off timeout is 20 seconds in measurement mode and 30 seconds in MENU mode.

## Display

ST has a Primary Display, a Secondary Display, a Bar Graph and a Test Frequency Indicator.



The sign in the bottom left corner of the display indicates that device is ON and ready to perform measurements. A, R, L or C indicate auto, resistance, inductance and capacitance respectively.

### Primary Display

The Primary Display is located in the middle of the screen and is the larger of the two displays available. It shows the present major parameter reading. For most functions the primary display shows 5 digits.

### Secondary Display

The Secondary Display is located at the top of the screen and is the smaller of the two displays. It shows the present reading of the minor parameters.

### Bar Graph

The Bar Graph provides an analog representation of the measured major parameter and is located at the bottom of the display.

### Displayed Parameters

The measurement mode settings (R+Q, L+R, C+R, and AUTO) determine the measurement type and the displayed parameters. The selected parameters are indicated above the two 5 digit displays.

#### **R+Q Mode**

Resistance is shown on the Primary Display and the quality factor,  $Q$ , on the Secondary Display. The resistance is either the equivalent series or parallel resistance of the device under test (DUT). The units of resistance are  $m\Omega$ ,  $\Omega$ ,  $k\Omega$ , or  $M\Omega$ .  $Q$  is the ratio of the imaginary part of the impedance to the real part of the impedance and is dimensionless. If  $Q$  is positive, the reactive component of the DUT is inductive. If  $Q$  is negative, the reactive component is capacitive.

#### **L+R Mode**

Inductance is shown on the Primary Display and the series resistance on the Secondary Display. The units of inductance are  $\mu H$ ,  $mH$  or  $H$ . Resistance is the real part of the impedance. The units for resistance are  $m\Omega$  or  $\Omega$ .

#### **C+R Mode**

Capacitance is shown on the Primary Display and the parallel resistance  $R$ , is shown on the Secondary Display. The units of capacitance are  $pF$ ,  $nF$ , or  $\mu F$ . The units for resistance are  $\Omega$  or  $k\Omega$ .

#### **AUTO Mode**

ST determines which component model is the most accurate representation of the DUT and selects the appropriate parameter pair. The determination is made as follows:

If  $|Q| < 0.125$  the unit selects R+Q.

If  $Q > +0.125$  the unit selects L+R.

If  $Q < -0.125$  and the unit is in the series mode, it selects C+R.



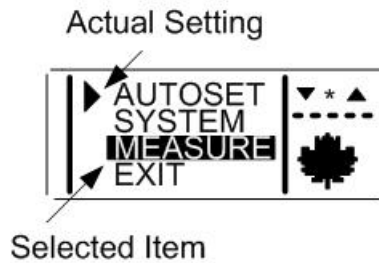
## Menu Structures And Functions

This section describes menu structure and parameters setting.

- Main menu – Covers main menu features
- System menu – Covers system menu features
- Sound menu – Covers sound settings
- Display menu – Covers display setting
- Period menu – Changes the reading period setting
- Measurement menu – Covers measurement menu structure and functions.
- Mode menu – Describes how to set measurement parameters.
- Voltage menu – Covers voltage measurements such as DC voltage measurements, DC offset calibration, dynamic signals indication and battery voltage measurement.

### General information

The Actual Setting cursor indicates the current setting. Turn Jog Dial left or right to the desired menu item and push Jog Dial to select.



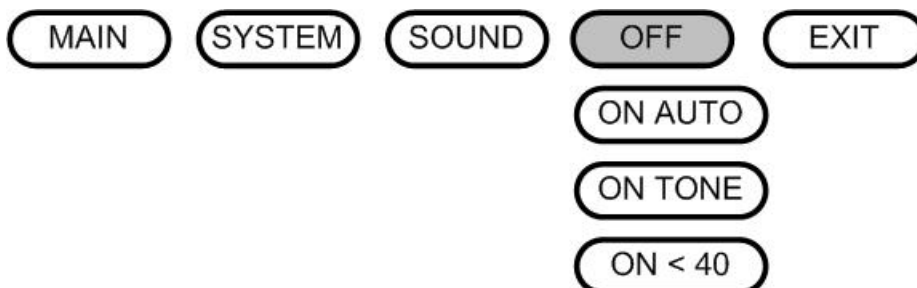
### Main menu

Main menu is used to access system menu, measurement menu or to return measurement parameters to default state.

Select AUTOSET to set parameters to default settings  
Select SYSTEM to change user interface parameters  
Select MEASURE to specify measurement settings



### System menu



## Sound menu

The Sound menu is used to change sound setting for measurement confirmation and continuity check mode.

Select OFF to disable sound except Jog Dial operation

Select ON AUTO to enable sound for measurement confirmation

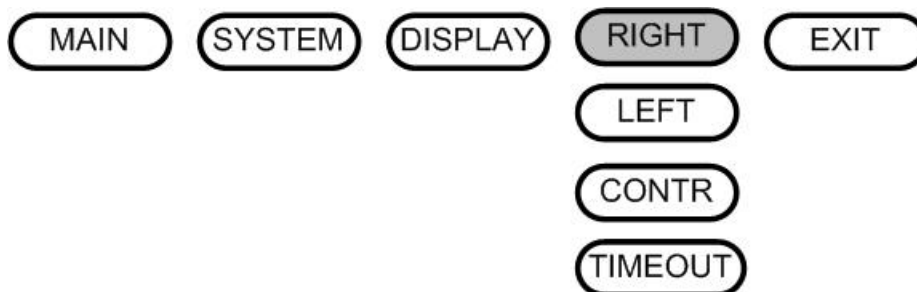
Select ON TONE to make the sound tone dependent of resistance value (less then 1Q measurement) in continuity check mode

Select ON<40Q to enable variable number of sound pulses (less then 40Q measurement) in continuity check mode



## Display menu

The Display menu is used to change the display settings



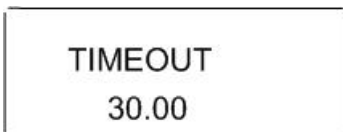
Select RIGHT to set "Right Handed" display mode

Select LEFT to set "Left Handed" display mode

Select CONTR to adjust display contrast. Turn Jog Dial left or right to change contrast. Press Jog Dial to exit menu

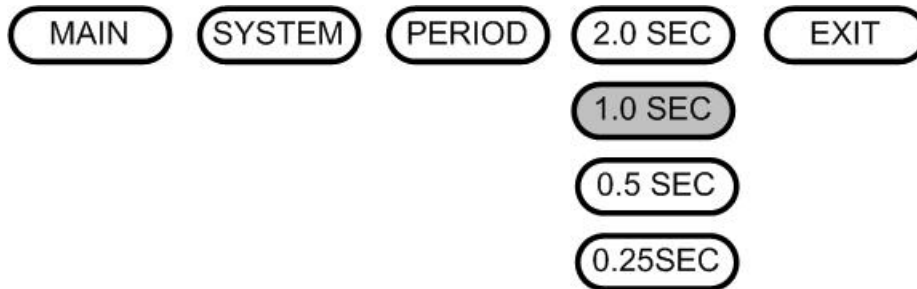
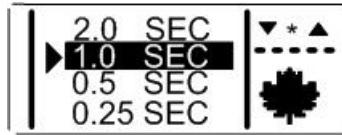


Select TIMEOUT to adjust "sleep" mode timeout. Turn Jog Dial left or right to change timeout value (10sec - 200sec) Press Jog Dial to exit menu



### Period menu

The Period menu is used to set period between measurements. Short period will reduce the battery life.



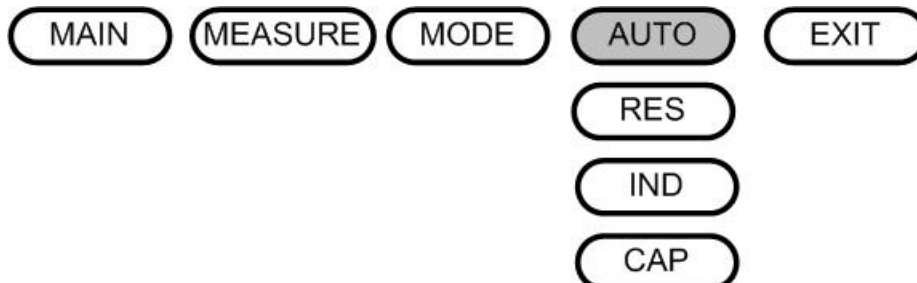
### Measurement menu

The default setting is to perform fully automatic auto range measurements for resistance, inductance and capacitance. The manual mode is used to measure specific parameters or to obtain better accuracy.



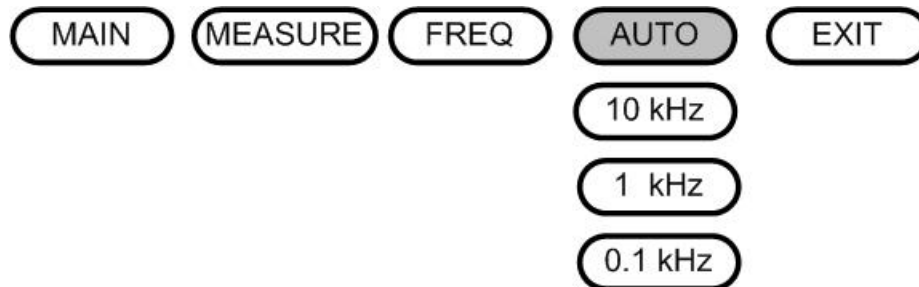
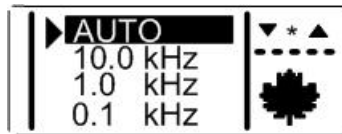
### Mode menu

The Mode menu is used to set the measurement mode. For automatic measurement select **AUTO** (default). Select **RES**, **IND** or **CAP** menu items to measure only resistance, inductance or capacitance accordingly.



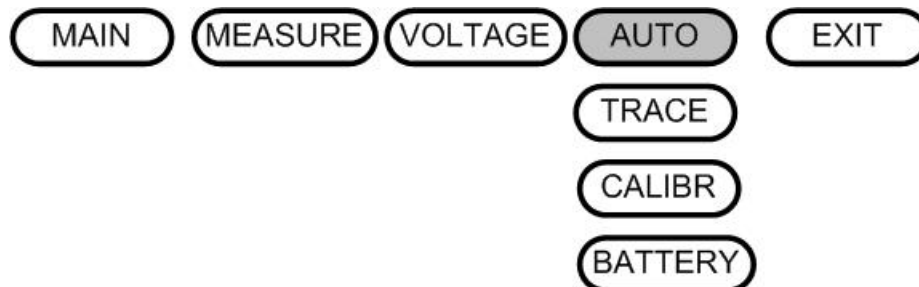
### Frequency menu

The Frequency menu is used to change the test frequency. For automatic measurement select AUTO (default). Select fixed test frequency for specific measurements, such as very small or very large capacitance (less than 50pF or more than 100uF) or inductance.



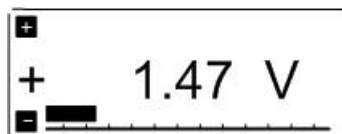
### Voltage menu

The voltage menu is used to select DC voltage measurement settings and to display oscilloscope-like picture for dynamic signals in TRACE mode

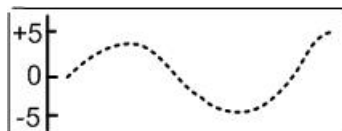


The voltage menu items are:

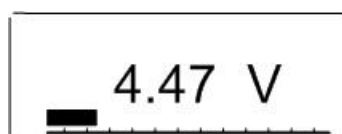
Select AUTO to measure DC voltage in -8V to 8V range



Select TRACE to display oscilloscope like picture of voltage as shown below. To change speed turn Jog Dial button LEFT or RIGHT. To exit press the Jog Dial button.



Select CALIBR to eliminate DC voltage offset. Select BATTERY to measure battery voltage. Press Jog Dial to exit



## MEASUREMENT FEATURES

This section describes specific ST functions and settings.

- Measuring resistance – Covers resistance measurements.
- Measuring capacitance – Covers capacitance measurements.
- Measuring inductance – Covers inductance measurements.
- Testing continuity – Describes continuity check.
- Testing diodes – Describes testing general-purpose diodes.
- Measuring voltage – Covers DC voltage measurements and TRACE mode for dynamic signals.

### Measuring Resistance

Test frequency	1 kHz
Test signal amplitude	440 mV (typical)
Test period	1 Sec (default)

#### Measuring small resistances

There is some small offset of resistance, which reflects tips resistance, and resistance of the contacts between the tips and DUT. Typical offset value is less than 25 mΩ. The offset value should be used in calculation of the actual resistance.

### Measuring Capacitance

Test frequency	0.1kHz, 1 kHz, 10kHz
Test signal amplitude	440 mV (typical)
Test period	1 Sec (default)

In AUTO mode Smart Tweezers automatically select the best test frequency and capable of measure capacitance from 4 pF to 4999 μF. If you need to measure capacitance lower than 4 pF use manual frequency settings.

Range	Optimal test frequency
<10000pF	10 kHz
10001pF- 1μF	1 kHz
> 1μF	100 Hz

Note: Due to low test signal level ST can shows lower capacitance readings (about 60% of actual value) for some types of ceramic capacitor (e.g. X5R).

There is some small capacitance offset that reflects probes capacitance and depends of distance between tips (measured component size). The offset value should be used in calculation of actual capacitance.

Table below shows typical offset values for different component sizes:

Component size	Offset, pF
1206	1.58
0805	1.60
0603	1.65
0402	1.70

## Measuring Inductance

Test frequency 0.1kHz, 1 kHz, 10kHz  
Test signal amplitude 440 mV (typical)  
Test period 1 Sec (default)

In AUTO mode ST automatically selects the best test frequency and is capable of measuring inductance from 1  $\mu$ H to 1kH. If you need to measure inductance lower than 5 $\mu$ H or more than 1 mH use manual frequency settings:

Range	Optimal test frequency
<100 $\mu$ H	10 kHz
100 H - 1mH	1 kHz
> 1mH	100 Hz

## Testing Continuity

Test frequency 1 kHz  
Test signal amplitude 440 mV (typical)  
Test period 1 Sec (default)

Options: Two audio profiles:

TONE mode - Sound signal changes tone according to the measured resistance. The lower tone represents lower resistance. Mode works when measured resistance less than 1 $\Omega$ .

BEEP mode - the numbers of beeps represents measured resistance.

Range	Number of BEEPS
< 10 $\Omega$	1
10 $\Omega$ - 20 $\Omega$	2
20 $\Omega$ - 30 $\Omega$	3
30 $\Omega$ - 40 $\Omega$	4

## Measuring Voltage

DC voltage measurements.

Input resistance 1 M $\Omega$   
Measured range -8V t +8V DC

Before making measurements, please perform offset calibration and change slide switch position.

Offset calibration procedure:

1. Select CALIBRATION function in VOLTAGE menu
2. Short the tips and wait until message DONE appears on display
3. Release the tips. The device is ready to perform DC Voltage measurement.

Dynamic signals real time indication:

Input voltage range -8V to +8V AC  
Input resistance 1 M $\Omega$

The refresh rate is limited by the LCD performance. User-defined refresh rate allows seeing either relatively fast or slow events. Before making measurements please change the slide switch position.

**Reading Serial Number: xxxxxx.xxx.x.xxx**

To find the electronic Serial Number from the ST-1, press and hold Jog Dial in right position

1. Reset device (press and release reset button)
2. After SN appears on LCD release Jog Dial.
3. Reset device again to return to normal mode.

## **MAINTENANCE**

### **General Maintenance**

Dirt or moisture on the tips may affect measurement accuracy. Clean the tips regularly. Do not use abrasives or solvents.

To clean the tips:

1. Turn the device off.
2. Shake out any dirt that may be on the tips.
3. Soak a new swab with alcohol. Work the swab around each tip.

### **Batteries**

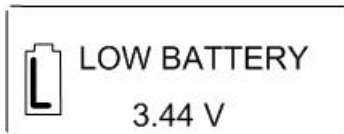
ST uses three 1.4V - 1.5V button type batteries, size 11.2x5.6 mm.

Alkaline type batteries: LR44, 357A, SG13, A76, AG13, L1154 etc.

Air Zinc type batteries: ZA675, VT675, XL675, 675A, etc.

### **Low Battery Indication**

The Low Battery message and battery icon in the display is an indication that the batteries are low and should be replaced. The warning appears when the battery voltage drops below 3.45V - the batteries are about 90% depleted. The unit is still operational for a short time, however the batteries should be replaced as soon as possible



### **To replace the batteries:**

1. Remove three screws and lift the cover.
2. Replace the batteries following the "+" and "-" sign.
3. Secure the cover.
4. Reset the device.

### **Troubleshooting**

If there appears to be a malfunction during operation of the device, the following steps should be performed in order to isolate the cause of the problem:

1. Reset device
2. Check slide switch position. If necessary, change slide switch position and the reset the device again.
3. Check the batteries. If necessary, change the batteries and reset the device.
4. Review the operating instructions for possible mistakes in the operating procedure.

**CAUTION:** Except for replacing the battery, a repair of the device should only be performed by an Authorized Service Center or by qualified service personnel.



## **LABELLING & VERIFICATION REQUIREMENTS**

This device complies with Part 15 of the FCC Rules.

Operation is subject to the following two conditions:

1. This device may not cause harmful interference; and,
2. This device must accept any interference received, including interference that may cause undesired operation.

## APPENDIX A. SPECIFICATIONS

### Technical Specifications

AC test mode Test frequency: 1 kHz, 10 kHz, 100 Hz  
Test frequency accuracy: 0.25%  
Test signal level: 440+- 20 mV via 402Ω source

### Maximum measurement ranges

Impedance/Resistance: 0.000Ω to 9.9 MΩ  
Capacitance C: 0.0 pF to 4999 uF  
Inductance L: 0.5 uH to 999 mH  
Quality factor Q: 0.0002 to 500  
Dissipation factor D: 0.002 to 500  
Phase angle F: -90.0 to +90.0 deg

### Maximum resolution

Impedance/Resistance Z or RAC: 10 mΩ  
Capacitance C: 0.1 pF  
Inductance L: 0.1 uH  
Quality factor Q: 0.001  
Dissipation factor D: 0.001  
Phase angle F: 0.1 deg  
Circuit diagram: 7 different equivalent circuit diagrams

### Auto mode Read-out:

Dominant parameter

### Equivalent circuit diagram:

Parallel for R+C  
Serial for R+L

### Manual Mode Read-out:

Dominant or secondary parameter

### Equivalent circuit diagram:

Parallel or serial

### Measurement update rate:

up to 4 measurements (1 default)

### Battery Type:

1.5 V LR44 (357A) Alkaline or Air zinc

### Battery Life:

70 Hours typical with alkaline, 200 hours  
with air zinc batteries

### Calibration Interval:

1 year

### Physical Specifications

Size: 14.0 x 2.5 x 3.0 cm (3.94 x 0.9 x 1.5 in)

Weight: 53 grams (0.11 lb)

### Environmental Conditions

Operating temperature: 0°C to 50°C

Storage temperature: -40°C to 70°C

Relative Humidity: 0 % to 90 % (0 °C to 35 °C)

Altitude Operating: 0 - 2000 meters

Storage: 10000 meters

### EMC:

According to CE regulation 89/336,  
Emission according FCC15 Class B.

## APPENDIX B. DEFAULT SETTINGS

### Default settings after RESET

SOUND mode:	OFF
DISPAY mode:	Right
Contrast:	FACTORY settings (middle)
Readings PERIOD:	1 sec
Measurement mode:	AUTO
Test frequency mode:	AUTO
Offset CALIBRATION:	FACTORY settings

### Default settings after AUTOSET command

SOUND mode:	OFF
DISPAY mode:	No change
Contrast:	No change
Readings PERIOD:	1 sec
Measurement mode:	AUTO
Test frequency mode:	AUTO
Offset CALIBRATION:	No change

## APPENDIX C. SERVICE REQUEST FORM

Model No. \_\_\_\_\_ Serial No. \_\_\_\_\_ Date \_\_\_\_\_

Name \_\_\_\_\_

Company \_\_\_\_\_

Address \_\_\_\_\_

E-mail \_\_\_\_\_ Telephone No \_\_\_\_\_

List all control settings, describe problem and check boxes that apply.

\_\_\_\_\_  
\_\_\_\_\_

### **Power**

- ☐ Problem on power-up  
☐ Device not turn-off  
☐ Other \_\_\_\_\_

### **LCD**

- ☐ No image on LCD  
☐ Missing vertical or horizontal lines  
☐ Bad contrast  
☐ Other \_\_\_\_\_

### **Mechanical**

- ☐ Jog Dial  
☐ Slide Switch  
☐ Tips  
☐ Other \_\_\_\_\_

### **Measurements**

- ☐ SMT component ☐ non-SMT component  
☐ Is it an in-circuit measurement?

\_\_\_\_\_

☐ **Capacitor** ☐ **Inductor** ☐ **Resistor**

Type (ceramic, tantalum, etc) \_\_\_\_\_

Value (uF, pF, uH,  $\Omega$ , etc.) \_\_\_\_\_

Test Frequency? \_\_\_\_\_ Ambient temperature? \_\_\_\_\_ Humidity? \_\_\_\_\_

☐ Other \_\_\_\_\_

- ☐ Additional information (attach any additional sheets as necessary)  
Show a block diagram of your measurement including all devices connected  
(whether power is turned on or not). If applicable, describe signal source.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

☐ Calibration only (Certificate of calibration required)

Be sure to include your name and phone number or e-mail on this service form.